

AIR FORCE QUALIFICATION TRAINING PACKAGE (AFQTP)



for
ELECTRICAL POWER PRODUCTION
(3E0X2)

MODULE 18
FUEL SYSTEMS

TABLE OF CONTENTS

MODULE 18
FUEL SYSTEMS

AFQTP GUIDANCE

INTRODUCTION..... 18-3

AFQTP UNIT 2

SERVICE FUEL SYSTEMS (18.2.) 18-4

AFQTP UNIT 4

FUEL SYSTEM COMPONENTS

INSPECT (18.4.1.)..... 18-9

REPLACE (18.4.3.) 18-14

AFQTP UNIT 5

TROUBLESHOOT (18.5.) 18-19

AFQTP UNIT 8

TIME FUEL PUMPS (18.8.) 18-23

AFQTP UNIT 9

TEST FUEL FOR WATER CONTENT (18.9.)..... 18-27

Career Field Education and Training Plan (CFETP) references from 1 Apr 97 version.

OPR: HQ AFCESA/CEOF
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Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

AIR FORCE QUALIFICATION TRAINING PACKAGES
for
ELECTRICAL POWER PRODUCTION
(3E0X2)

INTRODUCTION

Before starting this AFQTP, refer to and read the “Trainee/Trainer Guide” located on the AFCESA Web site <http://www.afcesa.af.mil/>

AFQTPs are mandatory and must be completed to fulfill task knowledge requirements on core and diamond tasks for upgrade training. It is important for the trainer and trainee to understand that an AFQTP does not replace hands-on training, nor will completion of an AFQTP meet the requirement for core task certification. AFQTPs will be used in conjunction with applicable technical references and hands-on training.

AFQTPs and Certification and Testing (CerTest) must be used as minimum upgrade requirements for Diamond tasks.

MANDATORY minimum upgrade requirements:

Core task:

AFQTP completion
Hands-on certification

Diamond task:

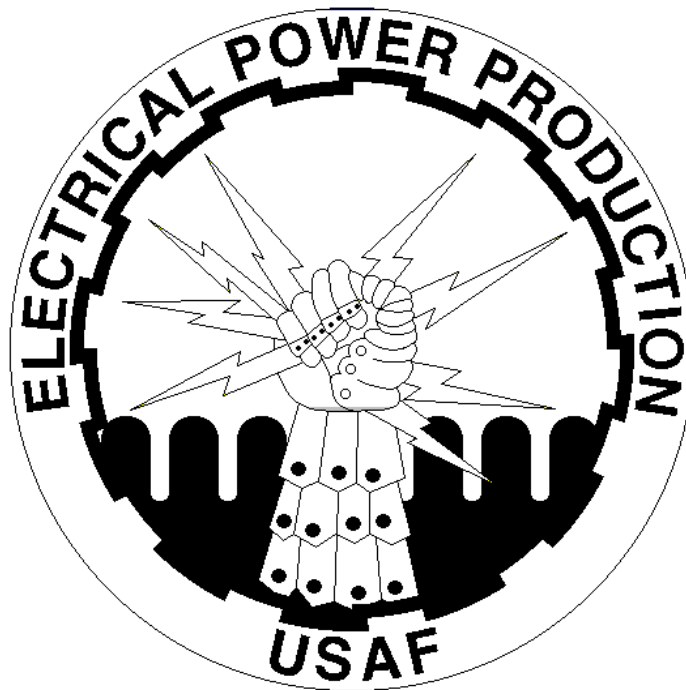
AFQTP completion
CerTest completion (80% minimum to pass)

Note: *Trainees will receive hands-on certification training for Diamond Tasks when equipment becomes available either at home station or at a TDY location.*

Put this package to use. Subject matter experts under the direction and guidance of HQ AFCESA/CEOF revised this AFQTP. If you have any recommendations for improving this document, please contact the Career Field Manager at the address below.

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FUEL SYSTEMS

MODULE 18

AFQTP UNIT 2

SERVICE FUEL SYSTEMS (18.2.)

Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

SERVICE FUEL SYSTEMS

Task Training Guide

STS Reference Number/Title:	18.2., Service Fuel Systems
Training References:	<ul style="list-style-type: none"> • CD-ROM, (3E0X2-18C, Fuel Systems) • 35C2 series Technical Orders
Prerequisites:	<ul style="list-style-type: none"> • Possess, as a minimum, 3E032 AFSC
Equipment/Tools Required:	<ul style="list-style-type: none"> • General tool box • Personal safety equipment
Learning Objective:	<ul style="list-style-type: none"> • Service the fuel system.
Samples of Behavior:	<ul style="list-style-type: none"> • The trainee will prime the fuel system • The trainee will service the fuel transfer pumps. • The trainee will service the fuel strainer. • The trainee will service the fuel filters.
Notes:	
<ul style="list-style-type: none"> • To successfully complete this element follow the steps outlined in the applicable technical manual exactly--no exceptions. • Any safety violation is an automatic failure. 	

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SERVICE FUEL SYSTEMS

Background: Technical Order 35C2-3-446-1 for the MEP-005A was used during the development of this AFQTP. Fuel for the generator set operation is supplied from either the main fuel tank located on the generator set or an auxiliary source as determined by the fuel selector valve. See (Figure 1) for a block diagram of a typical fuel system. Two electrically driven pumps which are controlled by the day tank fuel-level and the low-fuel cutoff switches transfer the fuel from the fuel source to the engine day tank. Before entering the day tank, the fuel passes through the fuel strainer and primary fuel filters. From the day tank the fuel passes through the secondary fuel filter to the injectors in the cylinder head. Excess fuel is returned to the day tank through the fuel return line. The two fuel pumps have filters that need to be serviced when you service the fuel system. Fuel strainers are located between the transfer pumps and the high-pressure fuel pump. The strainer's main objective is to remove coarse particles of dirt or debris. The fuel strainers are normally either metal-edged or wire-mesh types. Fuel filters are installed after the strainers and between the fuel pump and the fuel inlet manifold, and are designed to remove small particles of dirt or any moisture that passed through the strainers. Fuel filters are usually replaceable cartridge type.

Any time maintenance is performed on the fuel system and air has entered the system, the air must be bled off. On MEP style generators you can run the transfer pumps without running the generators. Push in CB1, turn on the battle short switch and put the Start-Run-Stop switch in the Run position. The transfer pumps should be running at this time. To prime the fuel system of air, the secondary fuel filter will have a bleeder plug which can be used. Vent the filter until all air is expelled and a solid stream of fuel is flowing. Continue venting the system to the injection pump. Since everything after the injection pump is pressurized as long as you don't open it up to air, you will not have to prime that part of the system.

If you have primed the system up to the injection pump and the engine still will not start due to lack of fuel, priming to the injectors will be necessary. The transfer pump can not prime the system after the injection pump. So you will need to open one of the injector lines and crank the engine until fuel comes out of the line, then close the line and restart the engine.

When pumping fuel into a generator set the generator must be shut down and the fuel truck must be grounded to the same ground as the generator.

SAFETY:

ALWAYS MAINTAIN CONSTANT METAL-TO-METAL CONTACT BETWEEN FUEL TANK FILLER NECK AND SPOUT OF FUEL SUPPLY. THIS WILL PREVENT THE POSSIBILITY OF SPARKING CAUSED BY STATIC ELECTRICITY

Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

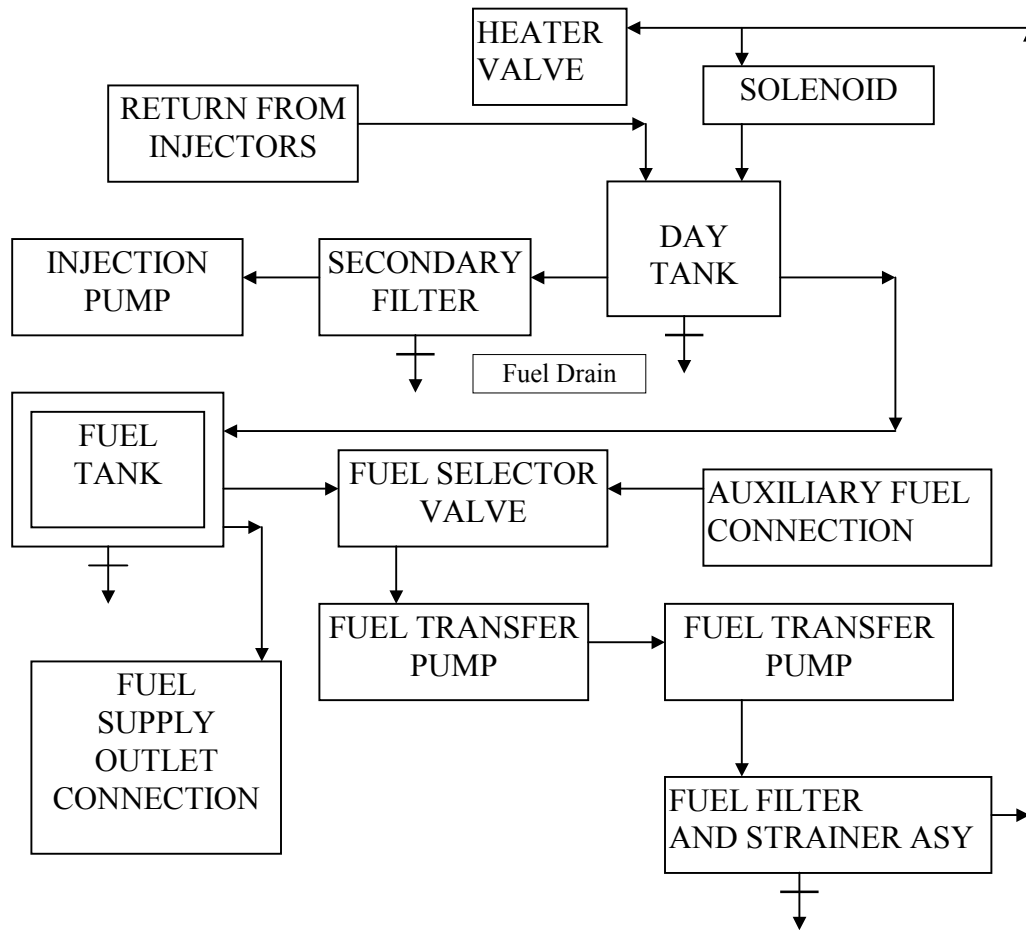


FIGURE 1, TYPICAL FUEL SYSTEM BLOCK DIAGRAM.

To perform these tasks, complete: CD-ROM, 3E0X2-18C Fuel Systems

NOTE: In the CD-ROM there are tests after each section. Complete each section and answer the questions.

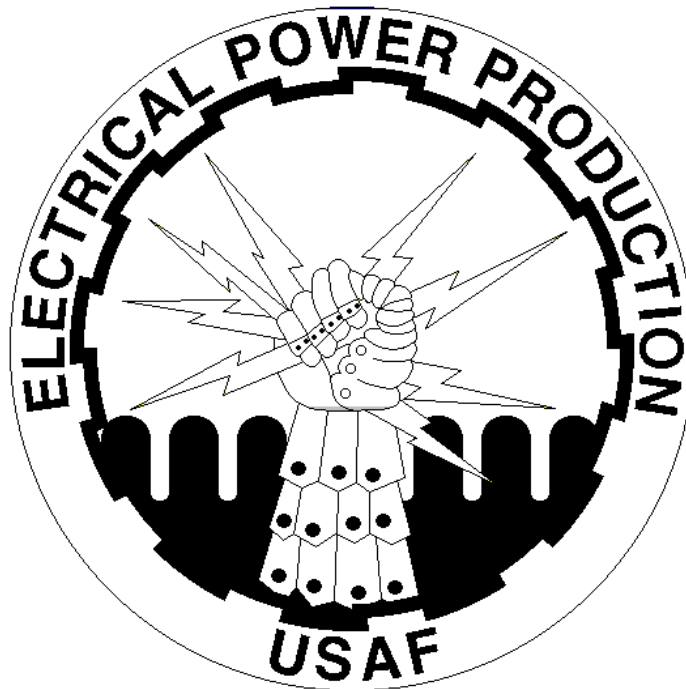
Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

SERVICE FUEL SYSTEMS

Performance Checklist		
Step	Yes	No
1. Serviced fuel transfer pumps		
2. Serviced the fuel strainer		
3. Serviced the fuel filter		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

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FUEL SYSTEM COMPONENTS

MODULE 18

AFQTP UNIT 4

INSPECT (18.4.1.)

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INSPECT

Task Training Guide

STS Reference Number/Title:	18.4.1., Inspect
Training References:	<ul style="list-style-type: none"> • CD-ROM, (3E0X2-18C, Fuel Systems) • 35C2 series Technical Orders • Manufacturer's manuals • Local procedures
Prerequisites:	<ul style="list-style-type: none"> • Possess, as a minimum, 3E032 AFSC
Equipment/Tools Required:	<ul style="list-style-type: none"> • General tool kit • Personal safety equipment
Learning Objective:	<ul style="list-style-type: none"> • Inspect fuel system components.
Samples of Behavior:	<ul style="list-style-type: none"> • The trainee will inspect the fuel pump. • The trainee will inspect the fuel transfer pump.
Notes:	
<ul style="list-style-type: none"> • To successfully complete this element follow the steps outlined in the applicable technical manual exactly--no exceptions. • Any safety violation is an automatic failure. 	

Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

INSPECT

Background: Refer to (Figure 1)The fuel system contains several components, including:

- **Fuel tank assembly** is where fuel is stored on the generator set. The fuel level sending unit senses the fuel level in the tank and transmits a signal to the fuel gauge. A drain on the tank permits draining of water and sediment from the tank.
- **Fuel transfer valve** is a mechanically operated three-way valve. It permits selection of fuel from the generator set fuel tank or an auxiliary fuel supply.
- **Electric transfer pumps** are 24-Volt DC pumps which draw fuel from the main fuel tank or an auxiliary fuel supply and pumps the fuel to the day tank at approximately 7 psi when the fuel solenoid valve is open. If the solenoid valve is closed, the pumps bypass fuel internally. The pumps are connected electrically in parallel; the fuel connections are in series.
- **Primary fuel filter and strainer** are the initial filtration devices in the fuel system. The strainer element removes course particles and is reusable after cleaning. The filter element removes smaller particles and moisture. It must be replaced when servicing the fuel system.
- **Fuel solenoid valve** is an electrically operated shutoff valve that opens and closes to maintain a predetermined fuel level in the day tank. When the day tank fuel level is decreased, the day tank float switch completes a circuit which directs electrical power to the fuel solenoid valve causing it to open. When the valve opens, fuel flows to the day tank until a predetermined level is reached. Electrical power is then removed from the solenoid valve by the float switch, closing the valve.
- **The day tank** has enough fuel to operate the engine for a minimum of five minutes. It provides a settling point for contaminants to prevent their entry into the engine and supplies fuel to the engine fuel pump. The tank contains a dual type float switch. The upper float operates in conjunction with the fuel solenoid valve to maintain a predetermined fuel level in the tank. The lower float initiates an engine shutdown sequence when there is only one minute of fuel consumption remaining--thus preventing the need for priming.
- **Secondary fuel filter** is the last filtration device in the fuel system. It removes contaminate particles of five microns and larger from the fuel.
- **Fuel injection pump** meters and pressurizes the fuel and sends it to the injectors. The fuel injection pump is driven by the camshaft gear at crankshaft speed. The injection pump varies fuel pressure to the injectors as engine speed varies.

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- **Injectors** produce a fine high velocity spray of fuel as it passes through the orifices (small openings) in the injector tip. The fuel sprays into the cylinder at pressures that exceed 1000 psi.

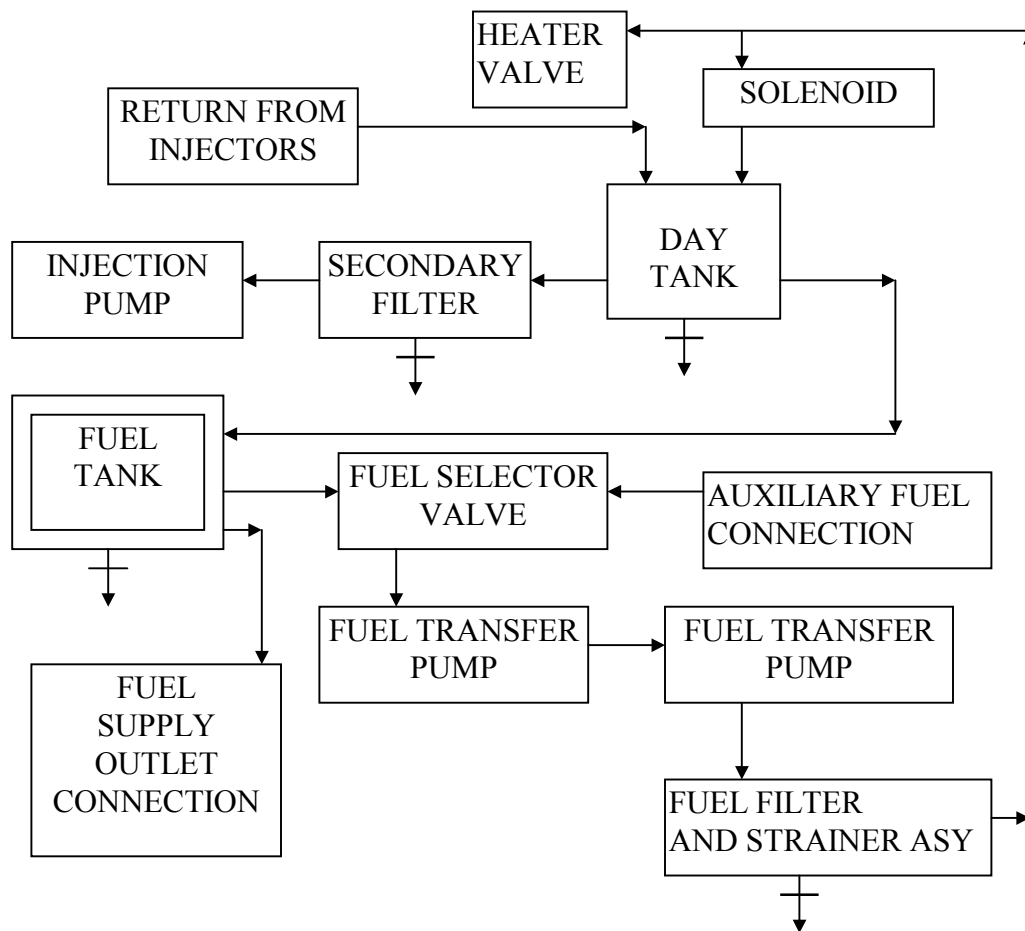


FIGURE 1, TYPICAL FUEL SYSTEM BLOCK DIAGRAM.

To perform these tasks, complete: CD-ROM, 3E0X2-18C, Fuel Systems

NOTE: In the CD-ROM there are tests after each section. Complete each section and answer the questions.

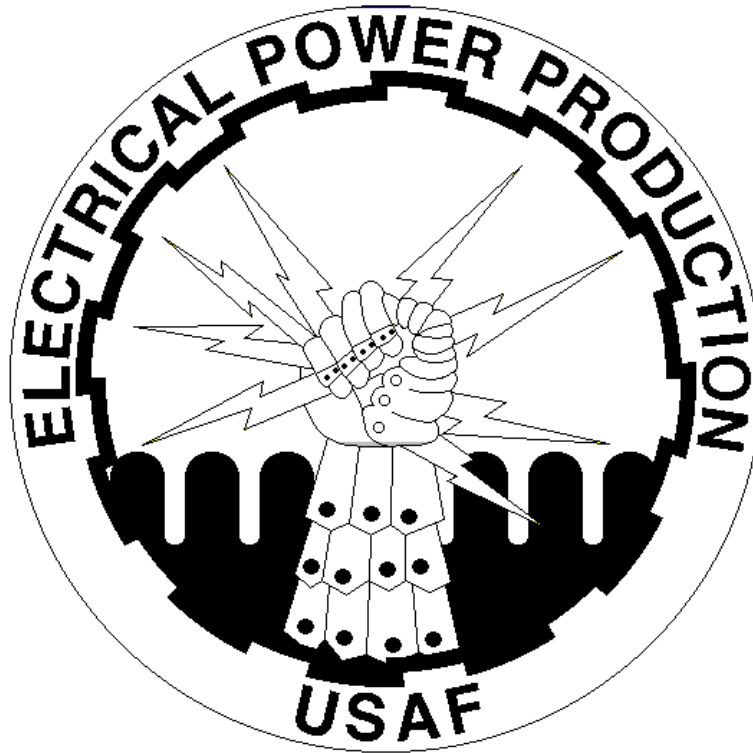
Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

INSPECT

Performance Checklist		
Step	Yes	No
1. Inspected fuel tank assembly		
2. Inspected fuel transfer valve		
3. Inspected electric transfer pumps		
4. Inspected primary fuel filter and strainer		
5. Inspected fuel solenoid valve		
6. Inspected day tank		
7. Inspected secondary fuel filter		
8. Inspected fuel injection pump		
9. Inspected injectors		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

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FUEL SYSTEM COMPONENTS

MODULE 18

AFQTP UNIT 4

REPLACE (18.4.3.)

Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

REPLACE

Task Training Guide

STS Reference Number/Title:	18.4.3., Replace
Training References:	<ul style="list-style-type: none">• CD-ROM, (3E0X2-18C, Fuel Systems)• 35C2 series Technical Order• Manufacturer's manual• Local procedures
Prerequisites:	<ul style="list-style-type: none">• Possess, as a minimum, 3E032 AFSC
Equipment/Tools Required:	<ul style="list-style-type: none">• General tool box• Personal safety equipment
Learning Objective:	<ul style="list-style-type: none">• Replace the fuel system components.
Samples of Behavior:	<ul style="list-style-type: none">• Replace fuel pump.• Replace transfer pump.
Notes:	
<ul style="list-style-type: none">• To successfully complete this element follow the steps outlined in the applicable technical manual exactly--no exceptions.• Any safety violation is an automatic failure.	

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REPLACE

Background : Refer to (Figure 1): This background section is the same as the one on the previous element however we felt the information was worth repeating. However, if you feel you have a clear picture of the fuel system components and their function continue with step one. The fuel system contains several components, including:

- **Fuel tank assembly:** This is where fuel is stored on the generator set. The fuel level sending unit senses the fuel level in the tank and transmits a signal to the fuel gauge. There is a drain on the tank to permit draining of water and sediment from the tank.
- **Fuel transfer valve:** It is a mechanically operated three-way valve. It permits selection of fuel from the generator set fuel tank or an auxiliary fuel supply.
- **Electric transfer pumps:** The 24-Volts DC pumps draw fuel from the main fuel tank or an auxiliary fuel supply and pump the fuel to the day tank at approximately 7 psi when the fuel solenoid valve is open. If the solenoid valve is closed, the pumps bypass fuel internally. The pumps are connected electrically in parallel; the fuel connections are in series.
- **Primary fuel filter and strainer:** These are the initial filtration devices in the fuel system. The strainer element removes course particles and is reusable after cleaning. The filter element removes smaller particles and moisture. It must be replaced when servicing the fuel system.
- **Fuel solenoid valve:** This is an electrically operated shutoff valve that opens and closes to maintain a predetermined fuel level in the day tank. When the day tank fuel level is decreased, the day tank float switch completes a circuit which directs electrical power to the fuel solenoid valve causing it to open. When the valve opens, fuel flow to the day tank until a predetermined level is reached. Electrical power is then removed from the solenoid valve by the float switch, closing the valve.
- **Day tank:** The day tank has enough fuel to operate the engine for a minimum of five minutes. It provides a settling point for contaminants to prevent their entry into the engine and supplies fuel to the engine fuel pump. The tank contains a dual type float switch. The upper float operates in conjunction with the fuel solenoid valve to maintain a predetermined fuel level in the tank. The lower float initiates an engine shutdown sequence in the event that the fuel level in the tank drops to a level that will permit the generator set to operate for only one minute at rated load--thus preventing the need for priming.
- **Secondary fuel filter:** This is the last filtration device in the fuel system. It removes contaminate particles of five microns and larger from the fuel.
- **Fuel injection pump:** The injection pump meters and pressurizes the fuel and sends it to the injectors. The fuel injection pump is driven by the camshaft gear at crankshaft speed. The injection pump varies fuel pressure to the injectors as engine speed varies.
- **Injectors:** Produce a fine high velocity spray of fuel as it passes through the orifices (small openings) in the injector tip. The fuel sprays into the cylinder at pressures that exceed 1000 psi.

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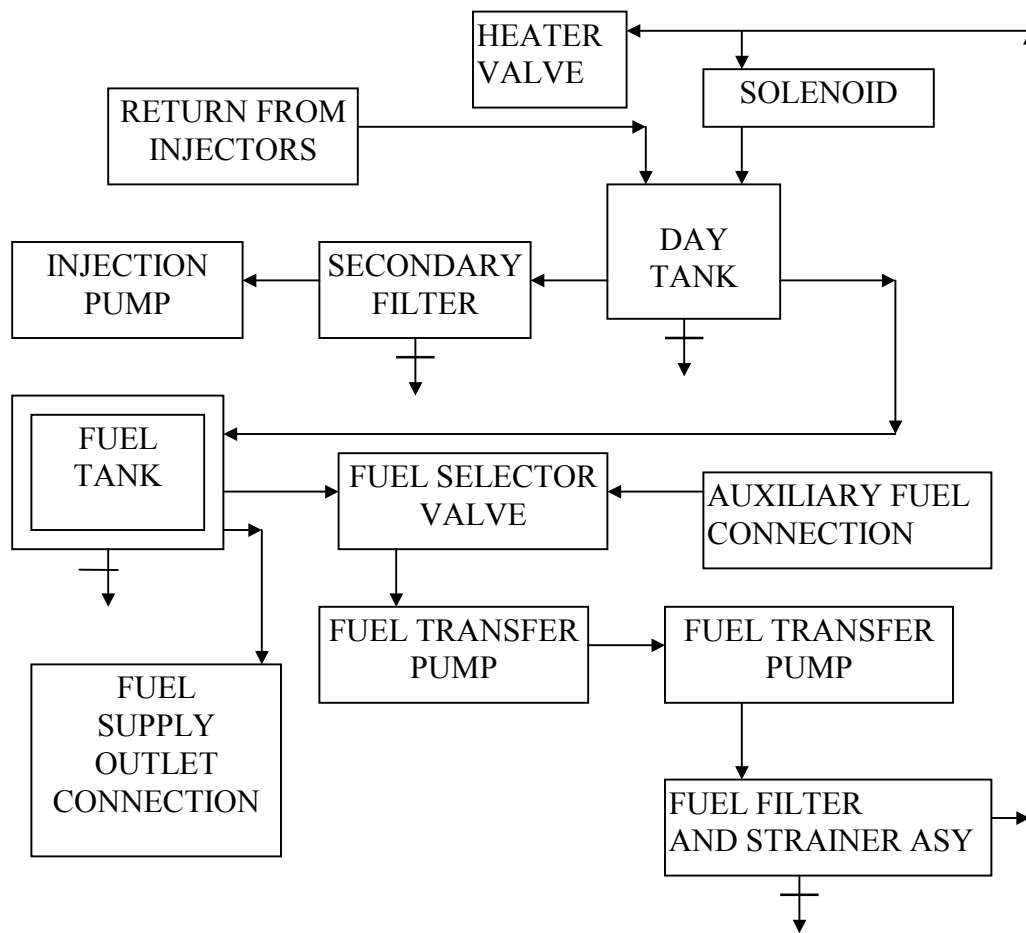


FIGURE 1, TYPICAL FUEL SYSTEM BLOCK DIAGRA

To perform these tasks, complete: CD-ROM, 3E0X2-18C, Fuel Systems

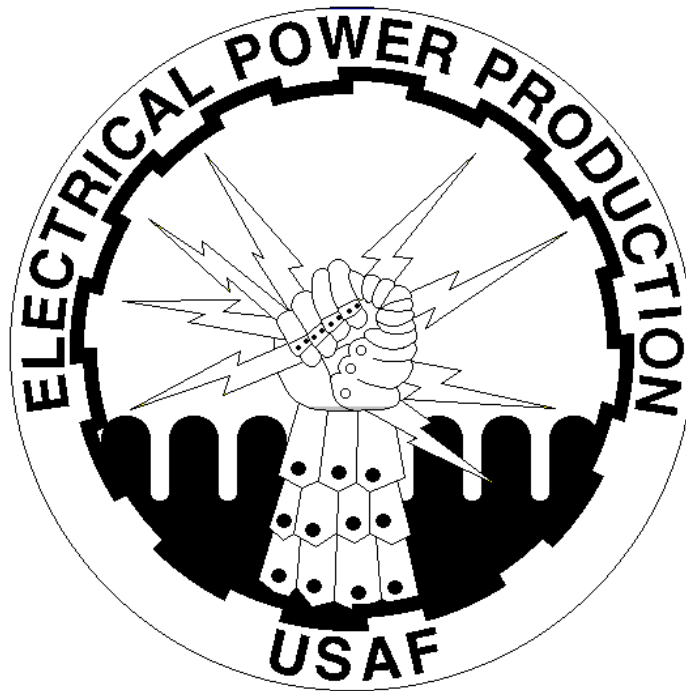
NOTE: In the CD-ROM there are tests after each section. Complete each section and answer the questions.

Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

Performance Checklist		
Step	Yes	No
1. Replaced fuel tank assembly		
2. Replaced fuel transfer valve		
3. Replaced electric transfer pumps		
4. Replaced primary fuel filter and strainer		
5. Replaced fuel solenoid valve		
6. Replaced day tank		
7. Replaced secondary fuel filter		
8. Replaced fuel injection pump		
9. Replaced injectors		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

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FUEL SYSTEMS

MODULE 18

AFQTP UNIT 5

TROUBLESHOOT (18.5.)

Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

TROUBLESHOOT

Task Training Guide

STS Reference Number/Title:	18.5., Troubleshoot
Training References:	<ul style="list-style-type: none"> • CD-ROM, (3E0X2-18C, Fuel Systems) • Manufacturers Manual • Local Procedures
Prerequisites:	<ul style="list-style-type: none"> • Possess, as a minimum, 3E032 AFSC • Use of hand tools
Equipment/Tools Required:	<ul style="list-style-type: none"> • General tool kit • Applicable technical references • Water detecting paste kit • Personal safety equipment
Learning Objective:	<ul style="list-style-type: none"> • Troubleshoot fuel system.
Samples of Behavior:	<ul style="list-style-type: none"> • Trainee will identify the causes and solutions to common troubleshooting scenarios.
Notes:	
<ul style="list-style-type: none"> • To successfully complete this element follow the steps outlined in the applicable technical manual exactly--no exceptions. • Any safety violation is an automatic failure. 	

Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

TROUBLESHOOT

Background: The generator set uses a pressure type fuel system. An individual fuel injection pump and an injection valve are provided for each of the six cylinders. The priming pump and fuel transfer pump supply fuel from the day tank to the injection pump housing. The injection pump housing manifold distributes the fuel, under pressure from the priming or fuel pumps, to each of the six fuel injection pumps. The pumps feed fuel to the six injection valves.

The tell-tale signs of a fuel related problem include: unit cranks but fails to start, engine lacks power, engine exhaust white or blue, or unit running erratically or misfires. Prior to troubleshooting, visually check the unit to ensure all valves and switches are in the correct configuration for operation. For example, ensure the fuel selector valve in the proper position for the desired source; check wire connections for conductivity; ensure fuel tank is not empty, etc. If a visual check reveals no discrepancies and the problem remains, begin troubleshooting.

NOTE:

The MEP 007B generator set was used to develop this AFQTP. If your particular fuel system varies from this unit, refer to the applicable technical reference.

To perform these tasks, complete: CD-ROM, 3E0X2-18C, Fuel Systems

NOTE: In the CD-ROM there are tests after each section. Complete each section and answer the questions.

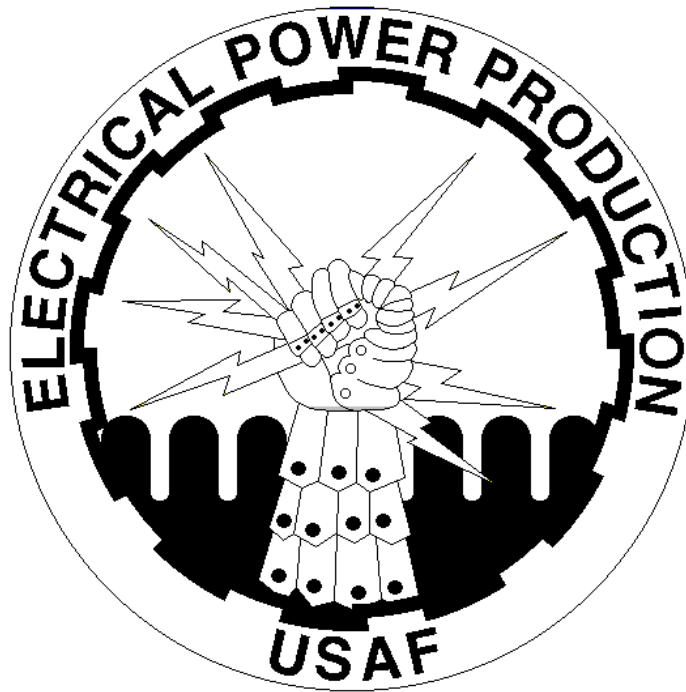
Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

TROUBLESHOOT

Performance Checklist		
Step	Yes	No
1. Gathered required equipment		
2. Bled air from the fuel system		
3. Checked components of the fuel system		
4. Tested fuel transfer pumps		
5. Checked the filters and fuel solenoid		
6. Primed the fuel system to the injection valves		
7. Troubleshoot an engine runs erratically		
8. Performed an isolation test		
9. Troubleshoot an engine with white or blue exhaust		
10. Tested fuel level switches		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

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FUEL SYSTEMS

MODULE 18

AFQTP UNIT 8

TIME FUEL PUMPS (18.8.)

Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

TIME FUEL PUMPS

Task Training Guide

STS Reference Number/Title:	18.8., Time Fuel Pumps
Training References:	<ul style="list-style-type: none"> • CD-ROM, (3E0X2-18C, Fuel Systems) • 35C2 series Technical Order
Prerequisites:	<ul style="list-style-type: none"> • Possess as a minimum a 3E052 AFSC
Equipment/Tools Required:	<ul style="list-style-type: none"> • General tool box • Personal safety equipment
Learning Objective:	<ul style="list-style-type: none"> • a fuel pump
Samples of Behavior:	<ul style="list-style-type: none"> • The trainee will reachTop Dead Center on a cylinder. • The trainee will check the timing marks on the fuel pump.
Notes:	
<ul style="list-style-type: none"> • To successfully complete this element follow the steps outlined in the applicable technical manual exactly--no exceptions. • Any safety violation is an automatic failure. 	

Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

TIME FUEL PUMPS

Background: If you have removed the fuel pump, and the shaft on the pump has rotated or the engine has been turned over you will need to re-time the fuel pump. If you are installing a fuel pump on an overhauled engine you will also need to re-time the fuel pump. There are different types of fuel pumps depending on the generator you are working. On larger units like the MEP-007B or the MEP-009 they use a pressure-time fuel system. The operation of the pressure-time fuel system is based on the principle that changing the pressure of a liquid flowing through a pipe of a fixed size changes the amount of liquid coming out of the open end; thus increasing the pressure increases the flow and vice versa. The fuel pump on a pressure-time fuel system is driven by the camshaft gear at crankshaft speed. The other type of system is the distributor-type fuel system which is designed for small variable speed diesel engines. Many small power production units use this type of fuel system like the MEP-004, MEP-005A and the MEP-006. The fuel pump on the distributor type fuel system is mounted on the timing gear case and is gear driven through an idler gear arrangement by the crankcase gear. The fuel injection pump attaching flange holes are elongated to permit accurate adjustment of the fuel pump timing. This AFQTP will discuss the fuel pump on the MEP-005A which is similar to the MEP-004 and the MEP-006 fuel pumps.

To perform these tasks, complete: CD-ROM, 3E0X2-18C, Fuel Systems

NOTE: In the CD-ROM there are tests after each section. Complete each section and answer the questions.

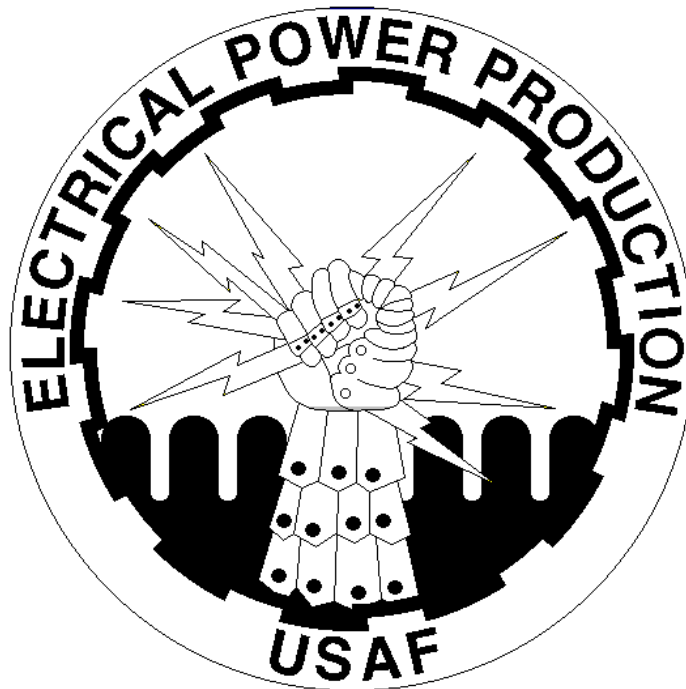
Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

TIME FUEL PUMPS

Performance Checklist		
Step	Yes	No
1. Positioned No 1 cylinder at TDC		
2. Lined up the timing marks		
3. Check timing marks		
4. Installed fuel pump		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

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FUEL SYSTEMS

MODULE 18

AFQTP UNIT 9

TEST FUEL FOR WATER CONTENT (18.9.)

Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

TEST FUEL FOR WATER CONTENT

Task Training Guide

STS Reference Number/Title:	18.9., Test Fuel For Water Content
Training References:	<ul style="list-style-type: none"> • CD-ROM, (3E0X2-18C, Fuel Systems) • Manufacturers Manual • Local procedures
Prerequisites:	<ul style="list-style-type: none"> • Possess, as a minimum, 3E032 AFSC • Use hand tools
Equipment/Tools Required:	<ul style="list-style-type: none"> • General tool kit • Applicable technical references • Personal safety equipment • Water finding paste
Learning Objective:	<ul style="list-style-type: none"> • Test fuel for water content.
Samples of Behavior:	<ul style="list-style-type: none"> • Trainee will safely test water for fuel and take necessary action
Notes:	
<ul style="list-style-type: none"> • To successfully complete this element follow the steps outlined in the applicable technical manual exactly--no exceptions. • Any safety violation is an automatic failure. 	

Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

TEST FUEL FOR WATER CONTENT

Background: Fuel storage for large power plants is generally in underground tanks while small portable generator sets have above-ground tanks. The tank capacity depends on the fuel demand and the transportation available. For example, small portable generator fuel tanks provide enough fuel capacity to operate approximately 72 hours under full load conditions.

To perform these tasks, complete: CD-ROM, 3E0X2-18C, Fuel Systems

NOTE: In the CD-ROM there are tests after each section. Complete each section and answer the questions.

Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

TEST FUEL FOR WATER CONTENT

Performance Checklist		
Step	Yes	No
1. Demonstrated a working knowledge of testing fuel for water?		
2. Performed test		
3. Made determination		
4. Removed water if present		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.